GROUND WATER 1.3

Ground water is sampled from various types of existing wells or wells installed specifically for a study.

- Water-supply wells are wells that are installed primarily for supply of public, irrigation, domestic, commercial, or industrial water and usually are equipped with a dedicated high-capacity pump. The term "supply well" is used in this publication.
- Observation wells are wells or piezometers that are installed (usually without a dedicated pump) for the purpose of collecting hydrologic data. The term generally has been applied to wells installed to observe and determine hydrologic characteristics of an aquifer (Lapham and others, 1997).
- Monitor wells are observation wells that are installed specifically for assessment of physical, chemical, and biological characteristics of the aquifer. Low-capacity portable pumps are commonly used for sampling, but monitoring wells can be equipped with a dedicated pump. The term "monitoring well" is used in this publication.

Information is compiled about the well and well site during site-reconnaissance visits, well installation, and subsequent data-collection efforts at the site. This information is used to help select the well(s) needed for study. The ground-water site inventory is compiled in the office and verified in the field. In an office inventory, the study team identifies existing wells or well sites and compiles background information and available records for those wells. The field inventory is completed during reconnaissance trips in which well location is verified, additional information is collected, and the suitability of the site for study objectives is determined. For each well, the inventory of site and well information is entered into the NWIS water-quality (QWDATA) and ground-water site inventory (GWSI) data bases and is added to the file created for the well (well file).

1.3.1 SITE RECONNAISSANCE AND WELL SELECTION

Field personnel critically evaluate existing and installed wells to determine whether they will yield samples that are representative of the environment targeted for study.

As a member of the study team:

- Be prepared to participate in office- and field-related aspects of selecting and installing wells (see Lapham and others, 1997, for details).
- Be familiar with study objectives and requirements for data collection and quality.
- Be familiar with considerations for well selection and well installation (summarized in table 1-2).

Information gathered from a site reconnaissance visit can help determine whether an existing well or a proposed well-installation site meets the criteria established by the study. Site reconnaissance visits also ensure efficient field operations and could be a critical factor in site selection or rejection. These site visits commonly are needed to verify the location and condition of wells, evaluate site characteristics, and make modifications to the site and adjustments to sampling plans to allow sampling to proceed. Before leaving for the site, determine the activities that are to be completed and make the necessary preparations (table 1-3).

Keep in mind the primary concerns for water-quality studies:

- The sample must represent the system intended for study.
- Sample integrity must be maintained.

Site visits also can be used to identify areas of ground-water recharge and discharge, test field equipment, test well-purging and sampling procedures, conduct aquifer tests, make preliminary field measurements, and identify the presence of target analytes.

Review safety plans and procedures before leaving for the field.

Table 1-2. Considerations for well selection and well installation

[Modified from Lapham and others, 1997]

Well location
• Location conforms to the study's network design for areal and depth distribution. • Land-use/land-cover characteristics, if relevant, are consistent with study objectives. • Site is accessible for equipment needed for well installation and sample collection.
Hydrogeologic unit(s)
• Hydrogeologic unit(s) that contribute water to the well can be identified. • Depth and thickness of targeted hydrogeologic unit(s) are known or can be determined. • Yield of water is adequate for sampling (typically, a minimum of 1 gallon per minute).
Well records, description, design, materials, and structure
• Available records (for example, logs of well drilling, completion, and development) have sufficient information to meet the criteria established by the study. • Borehole or casing/screen diameter is adequate for equipment. • Depth to top and bottom of sample-collection (open or screened) interval is known (to determine area contributing water to well). • Length of well screen is proportional to the vertical and areal scale of investigation. • Well has only one screened or open interval, if possible. (Packers can be used to isolate the interval of interest, but packers might not completely isolate zones in unconsolidated or highly fractured aquifers. If packers are used, materials of construction must be compatible with analytes to be studied.) • Top of well screen is several feet below mean annual low-water table to reduce chances of well going dry and to avoid sampling from unsaturated intervals. • Filter pack is of a reasonable length (a long interval compared with length of screened or open interval usually results in uncertainty as to location of the source of water to well). • Well-construction materials do not leach or sorb substances that could alter ambient target-analyte concentrations. • Well-structure integrity and communication with the aquifer are sound. (Checks include annual depth-to-bottom measurements, borehole caliper and downhole-camera video logs, and aquifer tests.)
Pump type, materials, performance, and location of sampler intake
• Supply wells have water-lubricated turbine pumps rather than oil-lubricated turbine pumps. (Avoid suction-lift, jet, or gas-contact pumps, especially for analytes affected by pressure changes, exposure to oxygen, or that partition to a gas phase.) • Pump and riser-pipe materials do not affect target-analyte concentrations. • Effects of pumping rate on measurements and analyses have been or will be evaluated. • Sampler intake is ahead of water treatments, pressure tanks, or holding tanks.

Table 1-3. Example of site-reconnaissance activities

Before the site visit
Review considerations for well selection and installation (summarized in table 1-2).
Review background information collected.
Obtain permission to gain access to the site and to collect samples from the well.
Update well files: record changes in ownership and land use.
Contact utility companies (gas, water, and electric) before digging or drilling.
Determine whether the pump may or may not be removed from well by field personnel. (Owner's permission is required to remove a pump—you could be liable for damage to pump or well.)
Be sure that you get information needed about the site that could interfere with or interrupt sampling. For example, • Hours of pump operation and scheduled downtime • Pumping rate or rates • Holding tanks or chemical treatments • Electrical service to the site • Scheduled maintenance for pumps or related equipment • Scheduled site maintenance, such as painting, construction, and defoliation • Seasonal water-level declines that make the well unusable • Times of denied access; for example, no access while the owner is out of town • Special site-access needs; for example, clearance with a site owner or site operator, keys to unlock access to the site, animals • Restrictions on the location
Record conditions that could compromise study objectives, including potential point or nonpoint sources of contamination. For example, • Nearby wells that could affect well hydraulics • Condition of well—for example, rusting or punctured casing, poor surface seal • Land use and land cover or changes in land use and land cover • Application of salt on nearby roads during winter, or application or use of herbicides and pesticides • Landfills or other waste-management facilities • Industrial, commercial, and agricultural complexes and discharges
During the site visit
Measure water level in each well. Record water-level data on the appropriate form(s).
Identify potential difficulties with the type of equipment and sample-collection methodology to be used. (Note that sampling plans will have to be modified accordingly.)
Update field folders. • Note site conditions that could affect the quality of data collected from that well. • Note change(s) in land use.
Verify well identification number and make sure that it is clearly and permanently labeled. • Check that identification corresponds with what is in the field folder and on site and location maps. • Correct any mistakes or uncertainty about well identification and well location.
Verify type of pump, well diameter, and use of holding tanks, pressure tanks, chemical treatments. • Check whether oil is floating on the water column in a well equipped with an oil-lubricated pump. • Make sure that the downhole treatment system is turned off before collecting water samples. • Determine if a portable pump or another intended sampling device is suitable for use.

Table 1-3. Example of site-reconnaissance activities—*Continued*

During the site visit—***Continued***
Establish optimum pumping rate(s) for purging and sample collection and decide where to route excess discharge. • Adjust pumping rate to ensure adequate purging of the well without entrainment of atmospheric gases due to excessive drawdown. • Route water away from the well to prevent (1) creating muddy and slippery conditions and (2) damage to or defacement of the property to which you were granted access.
Check that well structure is intact. • Wells used for ground-water studies should be "sounded" annually to check whether depth to bottom corresponds with well construction information or whether the well is filling with loose materials (U.S. Geological Survey, 1980; Lapham and others, 1997). A decrease in depth to bottom could indicate that the well casing is collapsing, or that there is a breach or corrosion of well screen or casing, or that the well is improperly designed to retain aquifer materials. • Borehole caliper and downhole-camera video logs can identify a damaged or broken well casing. A downhole camera can identify a plugged screen or accumulation of sediment in the well. • Aquifer tests, such as slug tests, can be used to check the hydraulic connection between the well and the aquifer. Aquifer tests, however, are generally beyond the scope of site reconnaissance. • The surface seal of a USGS monitoring well should be intact and the well should be capped. Concrete pad should be repaired if cracked or separated from outer casing. A tight-fitting well cap should have a small ventilation hole.
Check well access for sample-collection points. • Sample-collection points need to be near the wellhead, ahead of where water enters pressure tanks, holding tanks, or treatment systems. • At wells where an access point close to the well is not available, it might be possible to install a hose bibb or tap at the wellhead. Because it usually is not possible to control the pumping rate of a supply well, the field person may need to set up a hose-and-valve system to control the rate at which water is sampled and to reduce the likelihood of backflow of water stored in plumbing lines.
Check well access for water-level measurements. The construction of some supply wells makes water-level measurements difficult or impossible. • Although it is often possible to slip a weighted steel or electric well tape below the pump to get a water-level measurement, the pump can be damaged if the weight or tape becomes entangled in the pump. The weight should be connected so that it will snap off of the tape under stress. • Water levels can be estimated through the air line on some wells. • Sometimes field personnel are permitted to remove the pump from the well to get a measurement; however, pump removal can be difficult, time consuming, and potentially unsafe, and could damage the pump. • A note should be made in the well file if there is no access for a depth measurement.

1.3.2 INFORMATION FOR NATIONAL WATER INFORMATION SYSTEM (NWIS) FILES, WELL FILES, AND FIELD FOLDERS

USGS policy requires specific information on ground-water sampling sites to be stored in NWIS (Edwards and others, 1987; Hubbard, 1992; WRD Memorandum 92.59). Paper documents, such as agreements between the well owner and the USGS for use of the well, also are necessary and are stored in well files and field folders.

- Much of the information needed to set up files for existing wells can be obtained from well owners, drillers, records from state or local jurisdictions, and well-construction logs.
- Information that will be needed to set up well files for new wells is recorded by field personnel as the new well is installed (Lapham and others, 1997).

RULE OF THUMB:

Before starting fieldwork—Make sure the NWIS file is established.

After fieldwork—Update NWIS files promptly.

NWIS Files 1.3.2.A

Within the NWIS system, well information, ground-water levels, and water-quality data are stored in three data bases: the Ground-Water Site Inventory (GWSI), Quality of Water Data (QWDATA), and the Automatic Data Processing System (ADAPS). All wells for which data are stored must be identified by an electronic record in NWIS.

- GWSI primarily contains (1) descriptive information about the site and well and (2) noncontinuous water-level data. Specific information entered into GWSI is used to create an NWIS site file.
- QWDATA contains results of water-quality analyses, noncontinuous water-level data, and other data related to water-quality analysis.
- ADAPS contains continuous records of water levels and water quality.

The minimum information required for establishing electronic files in GWSI and QWDATA is shown in table 1-4. Individual studies and District offices may have additional data-storage requirements. For example, the GUNIT (geologic unit) code provides important information for ground-water studies.

When creating or updating a GWSI site-file record, fill in information that is needed by, or useful to, the study, in addition to the required information shown in table 1-4.

Table 1-4. Minimum information required for electronic storage of site and ground-water-quality data in the U.S. Geological Survey National Water Information System (NWIS)

[GWSI, Ground-Water Site Inventory; QWDATA, Quality of Water Data]

Information required for creation of a ground-water file in NWIS[1, 2] (GWSI)		
Data description	Component (C) number for data entry into GWSI	Example (Description of code)
Agency code	C4	USGS
Station Identification Number (Latitude/longitude/sequence no.)	C1	394224075340501
Station Name	C12	KE Be 61
Latitude	C9	394224
Longitude	C10	0753405
Station locator sequence number	C815	01
District/User	C6	24 (Maryland)
State	C7	10 (Delaware)
County	C8	003 (Sussex)
Agency Use	C803	A (Active)
Station Type	C802	6 (Well)
Data Reliability	C3	C (Field Checked)
Site Type	C2	W (Well)
Use of site	C23	O (Observation)
Information required for storage of sample analyses in the water-quality file of NWIS (QWDATA)[1]		
Data description	Alpha parameter code	Sample data (Description of code)
Agency code	AGNCY	USGS
Station Identification Number	STAID	394224075340501
Sample Medium	MEDIM	6 (ground water)
Sample Type	STYPE	2 (blank sample)
Hydrologic (“Hydro”) Event	EVENT	9 (routine sample)
Hydrologic (“Hydro”) Condition	HSTAT	A (not determined)
Date (year/month/day)	DATES	19880909
Time (standard 24-hour clock time)	TIMES	1530 hrs
Analysis Status	ASTAT	H (initial entry)
Analysis Source	ASRCE	9 (USGS laboratory and field)

[1]Numerous additional data fields from those shown are available in NWIS and QWDATA that can be useful for data analysis or mandatory for meeting study objectives; for example, indicating whether a non-USGS agency collected the data.

[2]From Ground-Water Site Schedule Form 9-1904-A, May 1991. Also refer to Mathey (1991) and Garcia and others (1997).

Well Files 1.3.2.B

A well file also must be established for each well selected or installed for the study or in a data network. At the outset of the study, it is useful to refer to a checklist of the items and types of information needed for the well file (fig. 1-3).

The well file is the repository of the information compiled for the well, and it should contain documentation for site selection, well inventory, well installation, and sample collection.

- Include well-construction information to the extent that it is available (Lapham and others, 1997).
- Include water-quality information, hydrogeologic field forms and logs, and plots of water-quality data and other hydrologic, geologic, geochemical, or geophysical information available for the well or field site.
- Include a log of well-maintenance and well-integrity checks and tests, geophysical logs and surveys, results of aquifer tests, analyses of cores or cuttings of geologic materials, and analyses from previously collected samples from the well or from a nearby well.

Field Folders 1.3.2.C

Selected information related to the well file and electronic records is kept in a field folder. The field folder contains information needed by personnel to locate and gain access to the site and to collect and process ground-water samples. The field folder should be taken along on each visit to the well for reference at the field site. The generic contents of a field folder are listed in the field folder checklist (fig. 1-4). Examples of site-location maps and a site sketch are shown in figure 1-5.

WELL-INFORMATION CHECKLIST, Page 1 of 2

Project name and identification number: _____
Latitude-longitude: _____ Sequence number: _____
Other site or well ID: _____ Station name: _____

Indicate well type: Public, Domestic, Commercial, Industrial, Irrigation, Observation, Monitoring, Other _____

Item in well file	Date item filed
Criteria for well selection or installation	_____
Ground-Water Site Inventory (GWSI) data entered into National Water Information System (NWIS)	_____
Paper copy of GWSI form	_____
Copies of agreement to complete activity (for example, drilling or sampling) _____	_____
List agreements _____	_____
Copies of field forms and logs:	
Well-drilling record	_____
Driller's log	_____
Lithologic log	_____
Cuttings	_____
Cores	_____
Aquifer tests: (list types)_____	_____
_____	
Geophysical logs: (list types)_____	
_____	
Well-construction record	_____
Well-development record	_____
Well-maintenance checks: (list types) _____	_____
_____	
Well-location information:	
Latitude-longitude and method of determination	_____
Well-location map(s)	_____
Site-sketch map	_____
Written description of location	_____
Well-casing elevation (elevation, and method and date of determination)	_____
Photographs of well and vicinity (with measuring/sampling points identified)	_____
Land use/land cover form (Lapham and others, 1997)	_____

Figure 1-3. Example of a well-information checklist for a well file and field folder.

WELL-INFORMATION CHECKLIST, Page 2 of 2

Item in well file	Date item filed
Water-quality records for each sampling event (for example, purging, field measurements, field forms, sampling history) and copies of laboratory analyses requested	_____
	_____
	_____
	_____
	_____
Water-level measurements - current:	_____
	_____
	_____
Water-level measurements - historical:	_____
	_____
	_____
Record of well leveling (survey)	_____
Pumping schedule/history	_____
Type of pump in well and location of intake	_____

Description of measuring point for water levels:_____

_____

_____

Description of collection point for samples from

Supply wells _____

_____

Monitoring wells _____

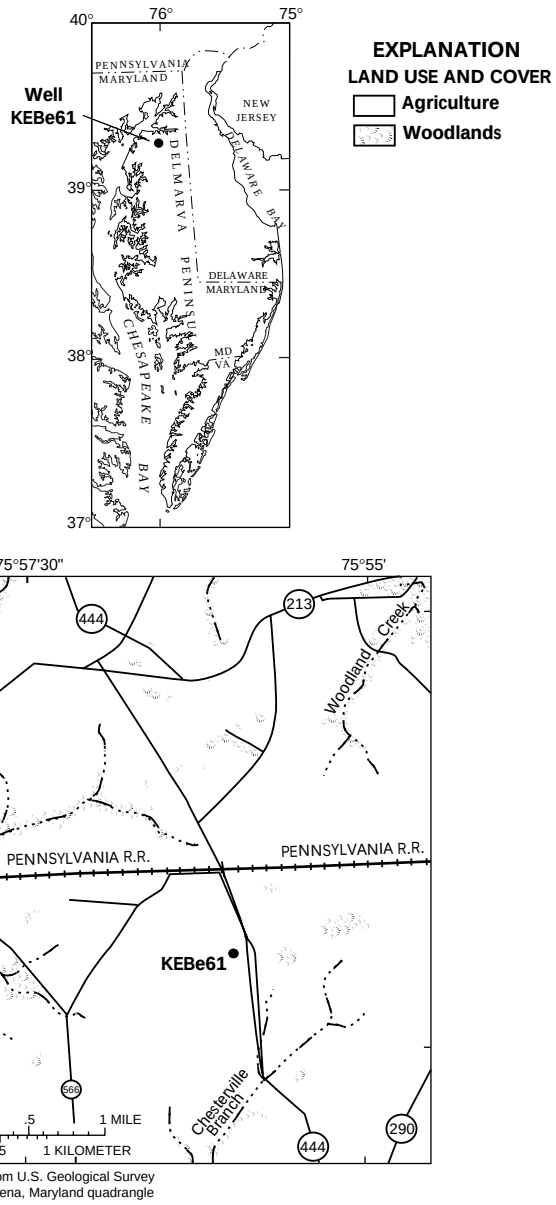
Other information (for example, geologic unit, aquifer name):

Figure 1-3. Example of a well-information checklist for a well file and field folder—*Continued*.

Field-folder checklist: ground-water quality		
✓	Item	Comments
	Forms (new forms and (or) examples of completed forms): • Permission forms—must be signed by proper authority. • Analytical Services Request form(s). • Ground-water field form and well-inventory form.	
	Equipment and supplies checklists.	
	Field-techniques manuals.	
	Site location and description: • Maps showing location and identification number of well(s). • Name of landowner, tenant, or other responsible party. • Site access instructions (call owner; get keys or tools needed for security gate, well house, well protective casing). • Photographs and land use/land cover form to document site conditions. • Well dimensions and construction.	
	Sampling schedule and instructions: • Laboratory analyses, codes, and bottle types. • Preservation requirements. • Quality-control samples. • Location of sampler intake during sample collection. • Pumping rate for purging and sampling.	
	Purging instructions: • Number of well volumes. • Rate of pumping; containment and discharge of purge water. • Location of sampler intake during purging. • Field measurements and stability protocols. • Previous field-measurement and purge-volume records. • Place to discharge excess water.	
	Water-level measurements: • Location of measuring point. • Previous records from well.	
	Safety information: • Nearest emergency facilities; home phone number of supervisor. • Diagram of where to park, placement of flags and cones. • Traffic conditions; location of power lines. • Environmental hazards such as weather and animals.	
	Ancillary information: • Geologic section(s). • Hydrologic section(s). • Borehole geophysical logs.	
	Shipping instructions: • Mailing labels; location of nearest post office or shipping agent. • Ice or holding time requirements.	

Figure 1-4. Checklist for contents of ground-water-sampling field folder

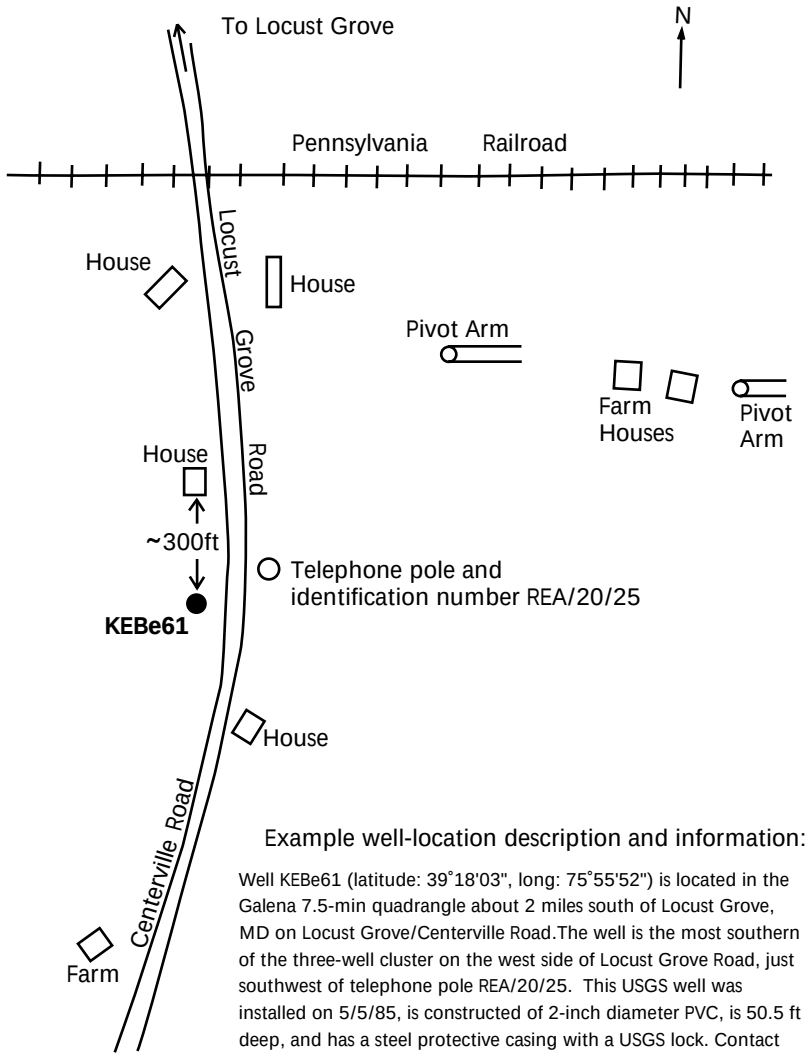
Example location map(s):



A.

Figure 1-5. Example of (*A*) site- and well-location maps and (*B*) well-site sketch with well-site information.

Example of site sketch:



Example well-location description and information:

Well KEBe61 (latitude: 39˚18'03", long: 75˚55'52") is located in the Galena 7.5-min quadrangle about 2 miles south of Locust Grove, MD on Locust Grove/Centerville Road.The well is the most southern of the three-well cluster on the west side of Locust Grove Road, just southwest of telephone pole REA/20/25. This USGS well was installed on 5/5/85, is constructed of 2-inch diameter PVC, is 50.5 ft deep, and has a steel protective casing with a USGS lock. Contact property owner at ( )___-____ the day before sampling.

B.

Figure 1-5. Example of (*A*) site- and well-location maps and (*B*) well-site sketch with well-site information—*Continued*.